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INSTITUTE OF TECHNOLOGY,

BOSTON, MASS.

DEPARTMENT

OF

MECHANICAL ENGINEERING.

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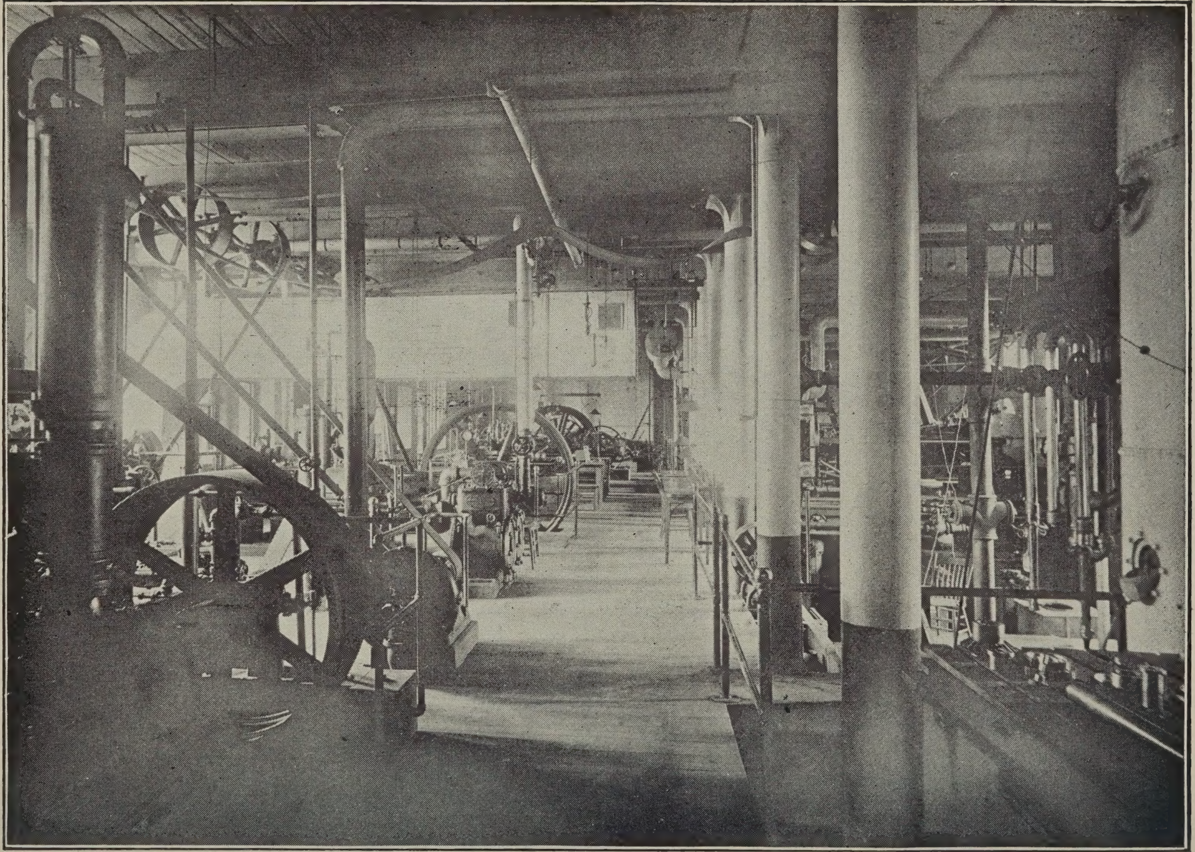


GENERAL VIEW OF A PORTION OF THE ENGINEERING LABORATORIES.

SCHEDULE OF THE COURSE IN
MECHANICAL ENGINEERING.

FIRST YEAR.

FIRST TERM.

Advanced Algebra.
Plane Trigonometry.
General Chemistry ; Chemical Laboratory.
Mechanical Drawing.
Freehand Drawing.
Rhetoric and English Composition.
French (or German).
Military Science.

SECOND TERM.

Advanced Algebra.
Analytic Geometry.
General Chemistry ; Qualitative Analysis. Chemical Laboratory.
Mechanical Drawing and Descriptive Geometry.
Freehand Drawing.
French (or German).
United States History.
Military Science.

SECOND YEAR.

FIRST TERM.

Principles of Mechanism.
Drawing.
Carpentry and Wood turning.
Differential Calculus.
Physics : Mechanics, Wave Motion, Electricity (lectures).
Descriptive Geometry.
German (or French).
English Literature.
European History.

SECOND TERM.

Mechanism : Cotton Machinery ; Machine Tools ; Gear teeth.
Drawing.
Pattern Work.
Foundry (elective).
Integral Calculus.
Physics : Electricity, Optics (lectures).
German (or French).
English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Steam Engineering ; Valve Gears : Thermodynamics.
Drawing.
Industrial Electricity.
Dynamo-Electric Measurements.
Forging.
Elements of Differential Equations.
General Statics.
Physics : Heat.
Physical Laboratory.
German (or French).
Political Economy.

SECOND TERM.

Steam Engineering ; Boilers.
Drawing, Design, Use of Surveying Instruments.
Engineering Laboratory.
Forging ; Chipping and Filing.
Strength of Materials ; Kinematics and Dynamics.
Physical Laboratory.
German (or French).
Political Economy and Industrial History.

FOURTH YEAR.

FIRST TERM.

Steam Engineering.
Machine Design.
Hydraulics.
Dynamics of Machines.
Engineering Laboratory.
Chipping and Filing ; Machine-Tool Work.
Strength of Materials ; Friction.
Heating and Ventilation.
Metallurgy of Iron.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

SECOND TERM.

Hydraulic Motors.
Engineering Laboratory.
Machine-Tool Work.
Strength and Stability of Structures ; Theory of Elasticity.
Foundations.
Shop Management.
Thesis.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

THE COURSE IN MECHANICAL ENGINEERING

COURSE II.

The Course in Mechanical Engineering is one of those established at the foundation of the school; it aims to give the student a thorough training in those scientific principles that form the basis of all engineering; and, by instruction, both theoretical and practical, to acquaint him with engineering practice, at the same time giving him a good liberal education.

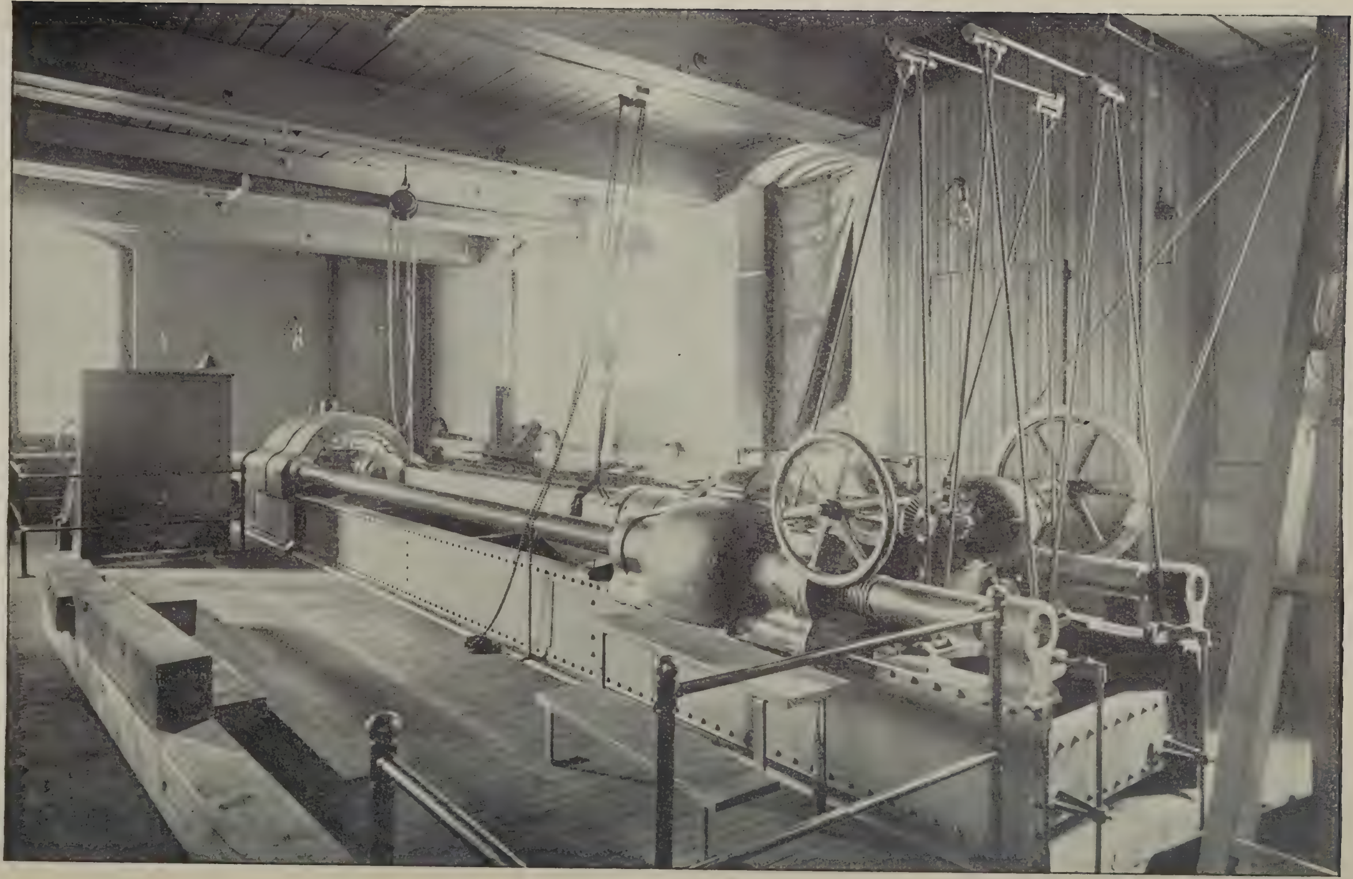
It is believed that such a procedure will furnish the best groundwork upon which to base a professional career.

OCCUPATION OF GRADUATES.

The first of the two following tables shows the number of graduates in this course for each successive year beginning with the school year 1867–68; and the second table shows the character of the occupations in which the living graduates are now engaged, and the number of graduates pursuing each occupation, omitting the Class of 1898.

Number of Graduates in Mechanical Engineering for Each School Year.

Year.	Number of Graduates.	Year.	Number of Graduates.	Year.	Number of Graduates.
1868	1	1879	8	1890	27
1869	2	1880	0	1891	25
1870	2	1881	5	1892	26
1871	2	1882	5	1893	30
1872	1	1883	7	1894	31
1873	2	1884	6	1895	30
1874	4	1885	7	1896	34
1875	6	1886	23	1897	40
1876	9	1887	17	1898	41
1877	6	1888	25		
1878	2	1889	24		448



TESTING MACHINE OF 300,000 POUNDS CAPACITY.

Occupations of the Living Graduates in Mechanical Engineering, 1868–97.

Railroads, including brakes and signals,	29
Textile industries and machinery,	30
Steam engine and steam pump works,	17
Steel and iron works,	14
General machinery,	27
Electrical works,	22
Ship and marine engine works,	16
Experts and consulting engineers,	27
Experts' assistants,	11
Special machinery and manufactures,	69
Teachers,	36
Mill insurance,	7
Refrigerating machinery,	4
Paper making,	4
Gas works,	2
Water and sewerage,	5
Lawyers and patent solicitors,	6
Building materials,	4
Cordage works,	2
Contracting engineers,	2
Photographic materials,	5
Testing laboratory,	1
Astronomy and meteorology,	2
Editor	2
Chemist,	1
Architect,	1
Military,	3
Surveyor and landscape gardener,	4
Doctors,	2
Artist,	1
Farmer,	1
In business,	27
Students,	1
No record,	4
	389

CHOICE OF COURSE.

Regular students at the Institute are expected to choose their professional courses at the close of their first term. In considering the propriety of undertaking the Course in Mechanical Engineering it should be borne in mind that, of the subjects studied in the first and second years, those most vital to success are mathematics, physics, and drawing (including descriptive geometry). All the later professional work of the Department is so completely dependent upon these branches that no student can expect to succeed in it without having mastered them. However much interest he may have in machinery in motion, when he attempts serious engineering work he must have a firm grasp of these fundamental subjects.

CLASSIFICATION OF STUDIES.

The professional work of the Course in Mechanical Engineering may be classified as follows: —

(*a*) Mathematics, Physics (including Technical Electricity) and Applied Mechanics, given outside the Department, the last including the study of and practice in testing the strength of materials.

(*b*) Class-room work of the Department proper.

(*c*) Drawing.

(*d*) Engineering Laboratory work.

(*e*) Shopwork.

(*f*) Visits to engineering works and manufacturing establishments.

Passing over the first year, in which the work of the different courses is mainly introductory and not greatly differentiated, the Course is organized as follows: —

In the second year the most fundamental subjects given outside the Department are differential calculus, integral calculus, and physics. The Department gives a course in the Principles of Mechanism, including the construction of gear teeth, and the mechanism of machine tools and of cotton machinery. In intimate connection with this, practice is given in making working drawings of parts of machinery from measurements, and other drawings, illustrating the class-room work. Instruction is also given in Carpentry and Pattern making at the shops.

The more technical subjects of the third year are: —

(*a*) Differential Equations.

(*b*) Physics, including a special study of Heat, and work in the Physical Laboratory.

(*c*) Industrial Electricity. This course includes a discussion in the lecture-room of the principal applications of electricity to the industrial arts, and in the laboratory the most important general methods of commercial electrical testing of dynamo machinery, and the use of the instruments ordinarily employed in such testing.

(*d*) Applied Mechanics, devoted mainly to a mathematical study of the strength of materials.

(*e*) Steam Engineering: Valve Gears, Thermodynamics. This course includes a detailed study of the principles of thermodynamics, mathematically treated; a discussion of the properties of gases and vapors, especially steam; of the flow of steam and other fluids, of the steam injector, and of the hot-air engine. All of these topics are treated in such a way as to give the student a good foundation in the principles of thermodynamics, especially as they apply to the steam-engine. This is followed by a study of the steam-engine itself, of the compound and multiple-expansion engine, and of the mode of testing steam-engines; the remainder of the course being devoted to a study of steam-boilers.

(*f*) Drawing. The course for the first term includes detail drawings, from measurement, of some machine, and assembly drawings made from these detail drawings. In the second term it is devoted to boiler drawing and the working out of valve gears and mechanism designs.

(*g*) Engineering Laboratory Work. This is given during the second term, and is devoted to drill in steam-engine tests, for which the 9-inch, 16-inch, and 24-inch by 30-inch Allis triple-expansion engine, and also the 11-inch and 19-inch by 15-inch tandem compound engine, are used. In these engine tests the water consumption is determined by condensing and weighing the steam after it has passed through the engine.

(*h*) Shopwork. The shopwork of the third year includes Forging and a portion of the Chipping and Filing.

FOURTH YEAR.

The work of the first three years, as above described, is taken by all students in the Course in Mechanical Engineering. In the fourth year three options are offered, of which one is required.

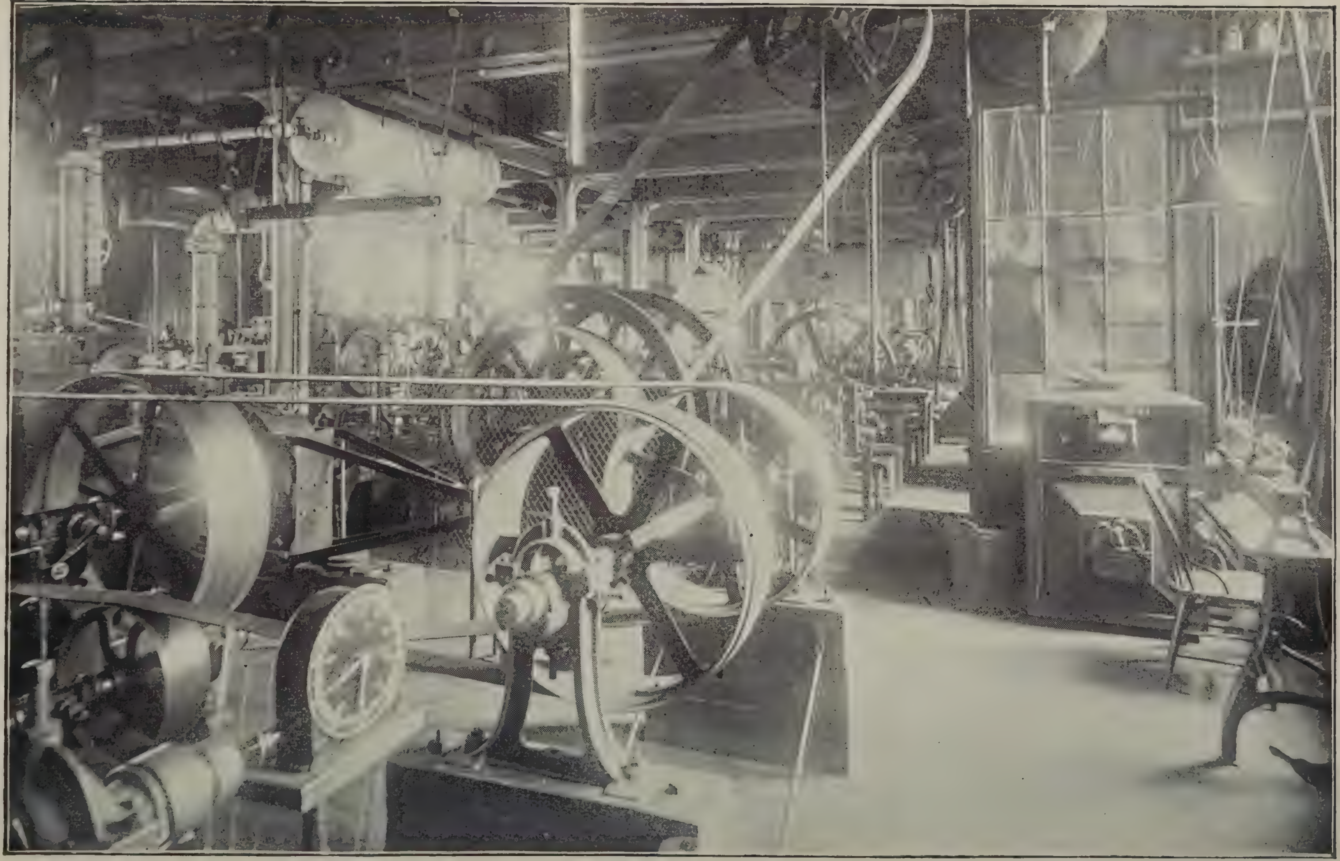
The following fourth-year subjects are pursued by all students: —

(*a*) Applied Mechanics. The earlier work in this subject aims to familiarize the students with such data on the strength of materials used in construction as have been obtained by means of experiments, especially those made on a practical scale, in different parts of the world. Pains is taken to keep this work well up to date. This is followed by a study of friction and lubrication, of continuous girders, of stone and iron arches, and of the theory of elasticity. Besides the above, the students have made during the school years (1896–97 and 1897–98) the following tests in the laboratory: —

1. Tests to determine the modulus of elasticity, the limit of elasticity and the tensile strength of cast iron, wrought iron, or steel rods or bars.
2. Tests of the deflections, and of the transverse strength of full size iron or steel I-beams, or of wooden beams, subjected to transverse loads.
3. Tests to determine the modulus of elasticity, and the tensile strength of annealed or bright iron wire.
4. Test to determine the shearing modulus of elasticity, and torsional strength of two-inch iron or steel bars.
5 Tests of the tensile strength of hydraulic cement.
6. Tests of the compressive strength of hydraulic cement.
7. Tests of the tensile strength of compositions.
8. Torsional tests of composition bars; of iron, steel, brass, and copper wires.
9. Tests to determine the strength of full-size timber trusses.
10. Tests of the strength of cast iron water pipes up to 48″ diameter.
11. Tests of the compressive strength of wrought iron pipe columns.
12. Tests of the tensile strength of bolted joints.
13. Tests of the strength of different kinds and sizes of ropes, and of different knots used in fastening ropes.
14. Tests of the strength of twine, window cord, belting, and belt lacing.

(*b*) Steam Engineering. A careful study is made of such data as have been based on reliable tests made on large single, compound, and multiple-expansion engines in different parts of the world. The gas-engine is studied, also air compressors and refrigerating machines.

(*c*) Machine Design. To this work are devoted nine hours per week during the first half-year. Each student is required to make a certain number of designs; as the design of a boiler, of a large shaft with gears and pulleys, of a set of hangers, etc.; and for each design he is required to make all the calculations and drawings necessary for every detail, determining the strength of every part by means of the principles already learned, and not by means of calculations made according to some empirical formula. The scope of



A PORTION OF THE STEAM LABORATORY.

the designs assigned is sufficiently limited to enable the student to complete every detail, by the application of knowledge already acquired, as it is believed that only by such thorough work can real benefit be obtained.

(*d*) Hydraulics and Hydraulic Motors. The main principles of hydraulics are taught, including the flow of water through orifices and pipes and over weirs. Hydraulic motors are studied with particular attention to the turbine.

(*e*) Shop Management. This involves a study of the organization and relations of the various departments of an industrial establishment, both in the office and in the workshop, the conduct of accounts, the methods of compensating labor and of superintendence, and a careful study of the effect on cost of production, of different ways of distributing indirect expenses.

(*f*) Engineering Laboratory Work. This can be best illustrated by the following list of the tests made by the students during the past two years: —

Tests of the transmission of power by belting.
Tests of the performance of a surface condenser.
Tests of a direct acting steam pump.
Tests to determine the accuracy of planimeters.
Tests to determine the accuracy of indicator springs.
Tests of a thirty-six horse-power gas engine.
Tests to determine the efficiency of jackscrews.
Tests to determine the efficiency of pulley blocks.
Tests of the flow of steam.
Valve setting (plain slide valve).
Tests of a pulsometer.
Tests of a centrifugal pump.
Calibration of orifices for the flow of water.
Determination of the clearance of an engine.
Use of the Emerson power scale.
Valve setting (double valve).
Tests of gauges by means of the mercury column.
Test of a 208 H. P. boiler, the test continuing for 104 hours, each man working eight hours.
Tests of the steam injector.
Use of three different kinds of calorimeters.
Tests of a Swain turbine.
Tests of a rotary pump of a capacity of 1000 gallons per minute.

Measurement of the flow of water by means of orifices and weirs.

Test of a 48″ Pelton water wheel.

Tests of a Rider hot-air engine.

Tests of an Ericsson hot-air engine.

Valve setting (Harris-Corliss engine).

Analysis of chimney gas.

Explosive force and time of reaching maximum pressure of different mixtures of gas and air.

Ratio of specific heats of air.

Tests of a battery of boilers of 200 H. P., each test lasting 24 hours, each student working eight hours.

Application of Hirn's analysis to the triple-expansion engine in the laboratory, run as a compound engine.

Forty-five-hour test on the engines, boilers, and generators at the Harvard Square power station of the Boston Elevated Railway Co., with four watches, each of eleven and a quarter hours, by a squad of twenty-five students.

Each test is performed by a squad of from two to five students, and the results are worked up and handed in within one week by each member of the squad.

(*g*) Heating and Ventilation (a short course).

(*h*) Metallurgy of Iron (a short course).

(*k*) Foundations.

(*l*) Shopwork, including Machine Tool Work and that portion of Chipping and Filing not completed in the third year.

(*m*) The Option.

(*n*) The Thesis.

It remains now to speak more in detail of the work done in the several options; the thesis work; the equipment of the engineering laboratory and of the workshops.

THE OPTIONS.

The Option in Locomotive Construction. This course begins with a careful study of the form and proportions of the details of the more usual types of locomotives, and of the strength of a number of the more important parts. Subsequently the following subjects are discussed, *viz:* train resistance; brakes; heating cars by steam from the locomotive; compound locomotives; the economy and performance both of simple and of compound locomotives, as shown by tests.

The Option in Marine Engineering. This includes a detailed study of the design and construction of single, compound, and multiple-expansion marine engines, with a discussion of their form, proportions, and efficiency, as well as the strength of the several parts.

The Option in Mill Engineering. Mill construction is studied, together with the processes to be carried out in a cotton mill, this study of processes being carried far enough to enable the student to take up intelligently the laying out of machinery to best advantage, including the planning of the power plant and the distribution of the power, all leading up to the designing and building of the mill itself; methods of rope and electrical transmission are also examined.

THESIS.

The thesis required of every candidate for graduation involves the investigation of an engineering problem. In connection with the thesis, a large amount of investigation is carried on under the direction of some one of the instructing staff. Many of the results are published from time to time in engineering periodicals; and it is partly by means of this work and partly by means of the regularly assigned laboratory work that the Department is enabled to carry on a large amount of original investigation (mostly experimental) in mechanical engineering subjects.

Some of the theses are performed by one student alone, but most of them are presented by two students who have worked together.

TITLES OF THESES OF THE CLASS OF 1898.

Design of a Machine for the Measurement of Pivot Friction.
by Robert Allyn.
An Investigation of Wind Pressure.
by Harrington Barker and Heber A. Hopkins.

Forms of Briquettes for Cement Testing.
by Henry C. Belcher.

A Series of Tests on a Water Ejector.
by John S. Bleecker and Walter G. Zimmerman.

The Variation in the Density of Steel under Stress.
by Howard L. Bodwell and William Brewster.

A Study of the Stresses in Timber Trusses.
by George H. Booth and Edward M. Taylor.

A Test on a Paper Calender.
by Elwell R. Butterworth.

An Experimental Study of the Application of Compressed Air to Shop Uses.
by Donald C. Campbell.

A Study of the Jet delivered by the Steam Injector.
by Paul Clifford and Harvey L. Currier.

A Design and Test of a Device to Reduce the Initial Condensation in a Steam Engine.
by Herbert F. Cobb.

An Investigation of the Variations of the Coefficient of Friction between Leather Belting and Cast Iron at Different Speeds of Slip.
by Howard L. Coburn and George O. Haskell.

A Design for a Repeated Stress Beam Testing Machine.
by Raymond H. Danforth.

Determination of Shaft Friction under Ordinary Working Conditions.
by Irving B. Dodge and James F. Muhlig.

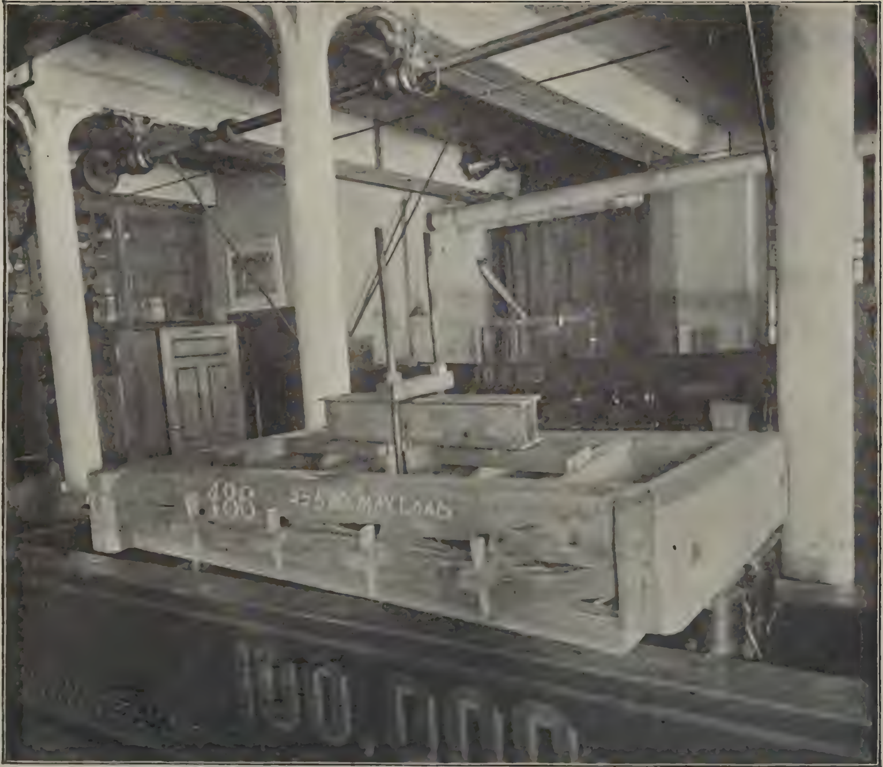
A Determination of the Initial Strains in Steel Shafting Due to Hammering.
by David C. Fenner.

Comparative Tests on Centrifugal Pumping Engine, Metropolitan Sewerage Commission, East Boston, Mass.
by Ernest A. Gallison.

Test on Rubber Calenders and Grinding Mills.
by Clarence Goldsmith.

A Study of Corliss Valve Gears.
by George A. Hutchinson.

Loss of Pressure of Air flowing Through Small Pipes.
by Paul F. Johnson.



TRANSVERSE TESTING MACHINE OF 100,000 POUNDS CAPACITY.

Efficiency Tests of a Hydraulic Elevator.
by Irvin H. Kaufman and Frank S. Tucker.

The Design of a 400-Ton Beet Sugar Plant.
by Samuel A. Neidich.

Tests of a Twelve-Foot Limestone Arch.
by Charles H. Pease and Albert R. Shedd.

An Investigation of the Distribution of Power in a Cotton Mill, and a Study of the Losses in Transmission.
by Frank B. Perry and Shirley S. Philbrick.

An Approximate Mean Effective Pressure Gauge for High Speed Engines.
by Joseph C. Riley.

Wear of Brake Shoes of Different Materials relatively to the Wear on the Wheel Tire.
by Eugene W. Rutherford.

A Study of an Axial Oil Machine with Tests upon the Coefficient of Friction of Babbitted Journals.
by Henry F. Scott and Charles H. Smith.

Study of the Effect of Repeated Bending Stresses in Rotating Bars.
by Mark E. Taylor.

An Investigation of the Action of a Blast Furnace Blowing Engine.
by John E. Warren and Edgar A. Weimer.

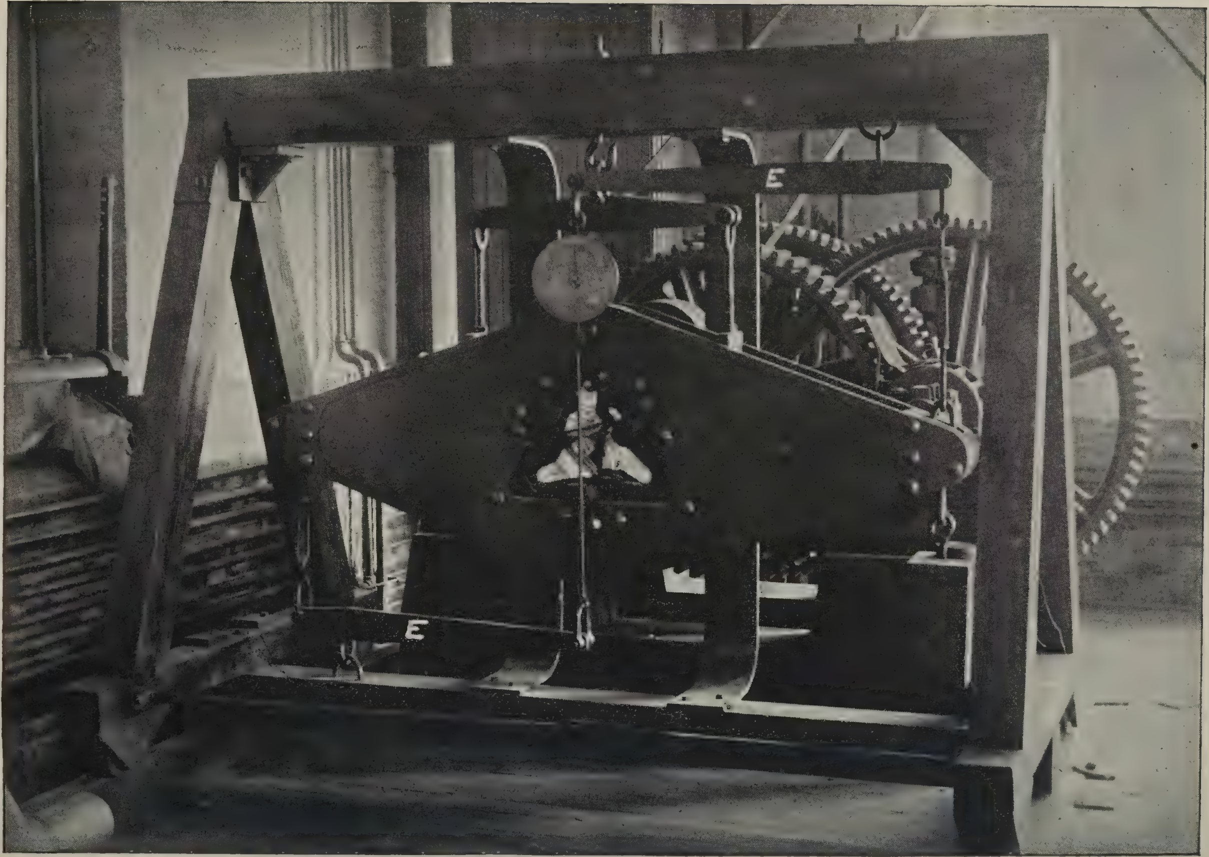
Tests on Riveted Joints with Special Reference to the Maximum Allowable Compression on the Bearing Surface, and its Influence on the Design of Triple Riveted Joints.
by Paul B. Wesson and Clifton W. Wilder.

THE ENGINEERING LABORATORIES.

The objects to be accomplished by these laboratories are the following: — First, to give the students practice in such experimental work as engineers in the pursuit of their profession are called upon to perform; second, to afford some experience in carrying on original investigations in engineering subjects, with such care and accuracy as to render the results of real value to the engineering community; third, by publishing, from time to time, the results of such investigations to add gradually to the common stock of knowledge.

These laboratories are situated in the buildings on Trinity Place, where they occupy a floor space of about 21,380 square feet.

The Laboratory of Applied Mechanics is furnished with the following apparatus for testing the strength of materials: a testing machine of one hundred thousand pounds capacity, and another of fifty thousand pounds capacity, for determining tensile strength, elasticity, and compressive strength; a testing machine of one hundred thousand pounds capacity for determining the transverse strength and stiffness of beams up to twenty-five feet in length, of framing-joints used in practice, and of other structures subjected to a transverse load; a testing machine of eighteen thousand pounds capacity for determining the transverse strength and stiffness of beams up to fourteen feet in length; apparatus for testing the strength of full-size masonry arches, and for studying experimentally the position of the true line of resistance; a machine for testing the torsional strength and stiffness of shafting up to three inches in diameter and to twenty-one feet in length; a small torsion machine of six thousand inch-pounds capacity, for very delicate work; machinery for the measurement of the twist of shafting; for testing the tensile strength of mortars and cements and of ropes; for testing the effect of repeated stresses upon the elasticity and strength of iron and steel; for determining the strength and elasticity of wire; for determining the strength and elasticity of cloth; for testing the strength of pipe and pipe-fittings under hydraulic pressure; for studying the wear of brake shoes and also of wheel tires; also accessory apparatus for measuring stretch, deflection, and twist. Besides the above, a horizontal Emery testing machine of three hundred thousand pounds capacity, purchased with a bequest from the late T. O. H. P. Burnham, forms a part of the equipment of this laboratory. It contains all the essential features of the eight hundred thousand pound testing machine at the Watertown arsenal, built by Lieut. Albert



TORSIONAL TESTING MACHINE.

H. Emery, and is suitable for testing a compression specimen eighteen feet long, and a tension specimen twelve feet long.

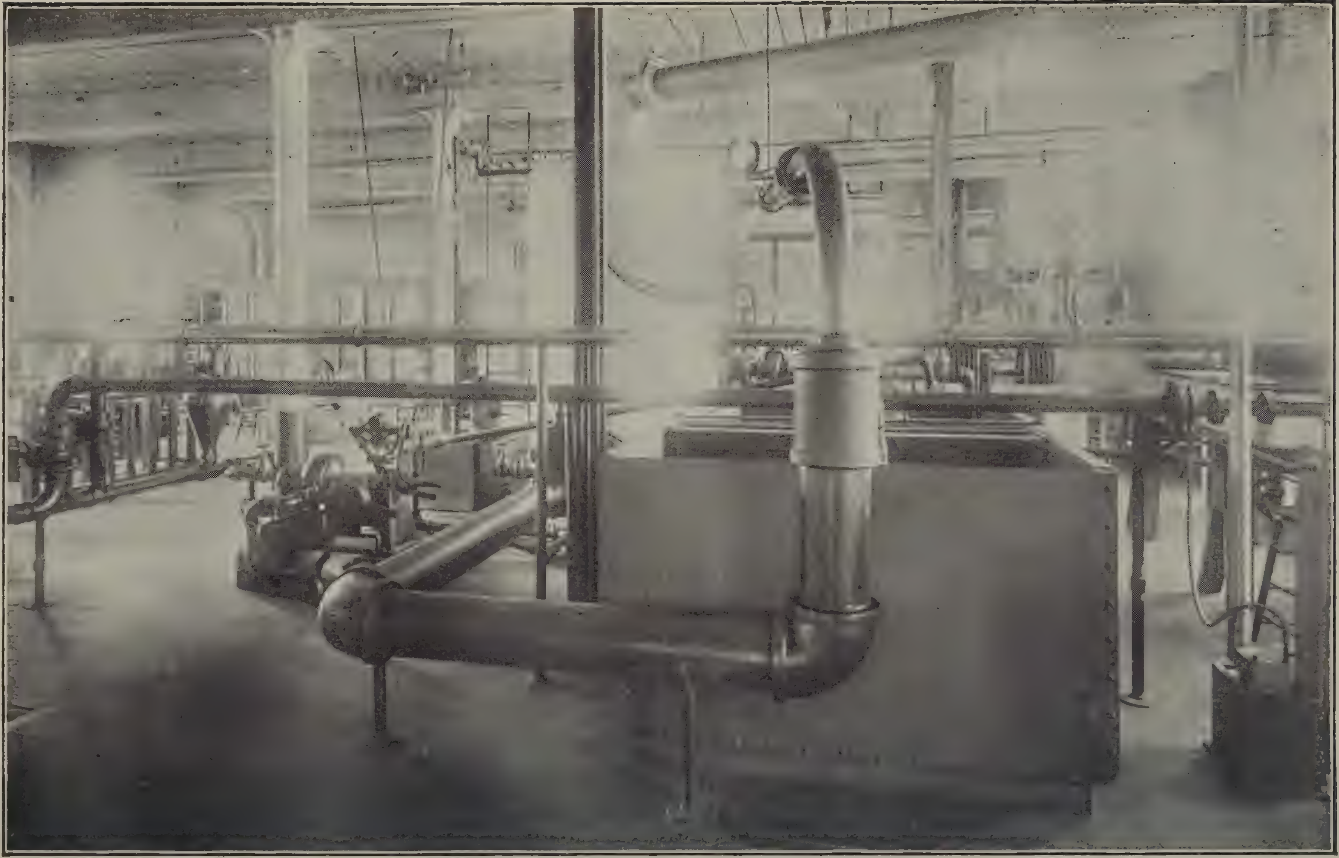
The Hydraulic Laboratory contains a closed steel tank, five feet in diameter and over twenty-seven feet high, arranged for the insertion of orifices, mouthpieces, and other special pieces of apparatus, with gates for controlling the discharge, and with connections for supplying water, in experiments upon pipes and motors. This tank is connected with a ten-inch standpipe over seventy feet high, so arranged that a constant head may be maintained at any desired level. Two steel tanks, each of about two hundred and eighty cubic feet capacity, give opportunity for the accurate measurement of larger quantities of water than can be weighed directly during experiments. A system of pipes connected both with the main tank and with the pumps is arranged for the insertion of diaphragms, branches, and other apparatus for studying loss of head and the laws of discharge. An attachment has been fitted to the main tank, containing a Pitot tube for studying the laws of velocity in jets, and adjustable points for accurate measurement of the cross-section of jets.

The laboratory is further equipped with a forty-eight-inch Pelton wheel, of thirty horse-power; a Venturi meter; an eight-inch, a twelve-inch, and two forty-eight-inch weirs for measuring water; also an orifice-tank for the same purpose; a centrifugal pump; a rotary pump; a plunger pump; a pulsometer; a three-inch water meter and others of smaller size; and a variety of mercury gauges, standard orifices, mouthpieces, diaphragms, branches, nozzles, etc., for experiments with flowing water under all conditions. A six-inch turbine is arranged to be run under various conditions of head and gate opening in tests for efficiency. There is also a hydraulic ram with a two-and-one-half-inch drive-pipe. The laboratory also contains a steel weir-box, the weir having a standard crest adjustable as to length from zero to five feet; and a seconds pendulum, with chronograph, for exact determination of time in experimental work. Water is supplied directly for experiments by the various pumps.

The Steam Laboratory contains a triple-expansion engine, with cylinders of nine inches, sixteen inches, and twenty-four inches diameter, respectively, and thirty inches stroke, arranged in such a way as to be run single, compound, or triple, as desired for the purposes of experiment. This engine is of the Corliss type, and has a capacity of about one hundred and fifty horse-power when running triple, with an initial pressure of one hundred and fifty pounds in the high-pressure cylinder. It is connected with a surface condenser and other apparatus necessary to adapt it to the purposes of accurate experiment. It also contains an 11 inches and 19 inches by 15 inches tandem compound engine provided with a surface condenser and the other apparatus necessary to adapt it to the purposes of experiment.

This laboratory also contains a sixteen horse-power engine, and an eight horse-power engine, used for giving instruction in valve setting, etc.; also a thirty-six horse-power gas-engine and a small gas-engine. It is equipped with several surface condensers, steam pumps, injectors and ejectors, calorimeters, mercurial pressure and vacuum columns; apparatus for determining the quantity of steam issuing from a given orifice or through a short tube under a given difference of pressure; apparatus for testing steam-engine indicators; apparatus for testing injectors; and with indicators, planimeters, gauges, thermometers, anemometers, and other accessory apparatus.

The engineering laboratories are provided with a number of friction brakes; with machinery for determining the tension required in a belt or rope to enable it to carry a given power, at a given speed, with no more than a given amount of slip; with four transmission dynamometers; with two machines for determining the coefficient of friction of lubricating oils; with a pendulum governor arranged for experimental purposes; with a complete set of Westinghouse air-



A PORTION OF THE HYDRAULIC LABORATORY.

brake apparatus, including the parts belonging to the car and to the locomotive; with the pump and engineer's valve of the New York air-brake; with a locomotive link model; with two hot-air engines; and with cotton machinery as follows: two cards, a drawing-frame, a speeder, a fly-frame, a ring spinning-frame, and a mule, as well as accessory apparatus. There are available for the purposes of experiment in connection with the work of these laboratories four horizontal tubular boilers in a boiler-house near the Engineering Building; a wrought-iron stack, three feet in diameter and one hundred feet high, fitted with the apparatus necessary to make experiments on the draft of chimneys; two large sectional boilers, situated in the Rogers Building; also another boiler, a forty horse-power engine, a number of looms, and other apparatus, in the workshops on Garrison Street.

SHOPWORK.

Practical instruction in the nature of the materials of construction, and in the typical operations involved in the arts, is considered a very valuable adjunct to the theoretical treatment of professional subjects. Workshops have been provided with the more important hand and machine tools, so that the student may acquire a direct knowledge of the nature of metals and woods, some manual skill in the use of tools, and a thorough knowledge of what can be accomplished with them. The shops are located on Garrison Street, and are equipped as follows: —

The carpentry, wood-turning, and pattern-making departments contain forty carpenter's benches, two circular saw-benches, a swing-saw, two jig-saws, a buzz-planer, a mortising machine, thirty-six wood-lathes, a large pattern-maker's lathe, and thirty-six pattern-maker's benches. The foundry contains a cupola furnace for melting iron, two brass furnaces, a core-oven, and thirty-two moulder's benches. The forge-shop contains a power hammer, thirty-two forges, seven blacksmith's vises, and one blacksmith's hand-drill. The machine shop contains twenty-three engine-lathes and seventeen hand-lathes of approved patterns, two machine-drills, three planers, a shaping machine, two universal milling machines, furnished with spiral and gear-cutting attachments, a universal grinding machine, a cutter and reamer grinder, thirty-two vise-benches arranged for instruction in vise-work, a twenty-four-inch standard measuring machine, and a fully equipped tool-room.

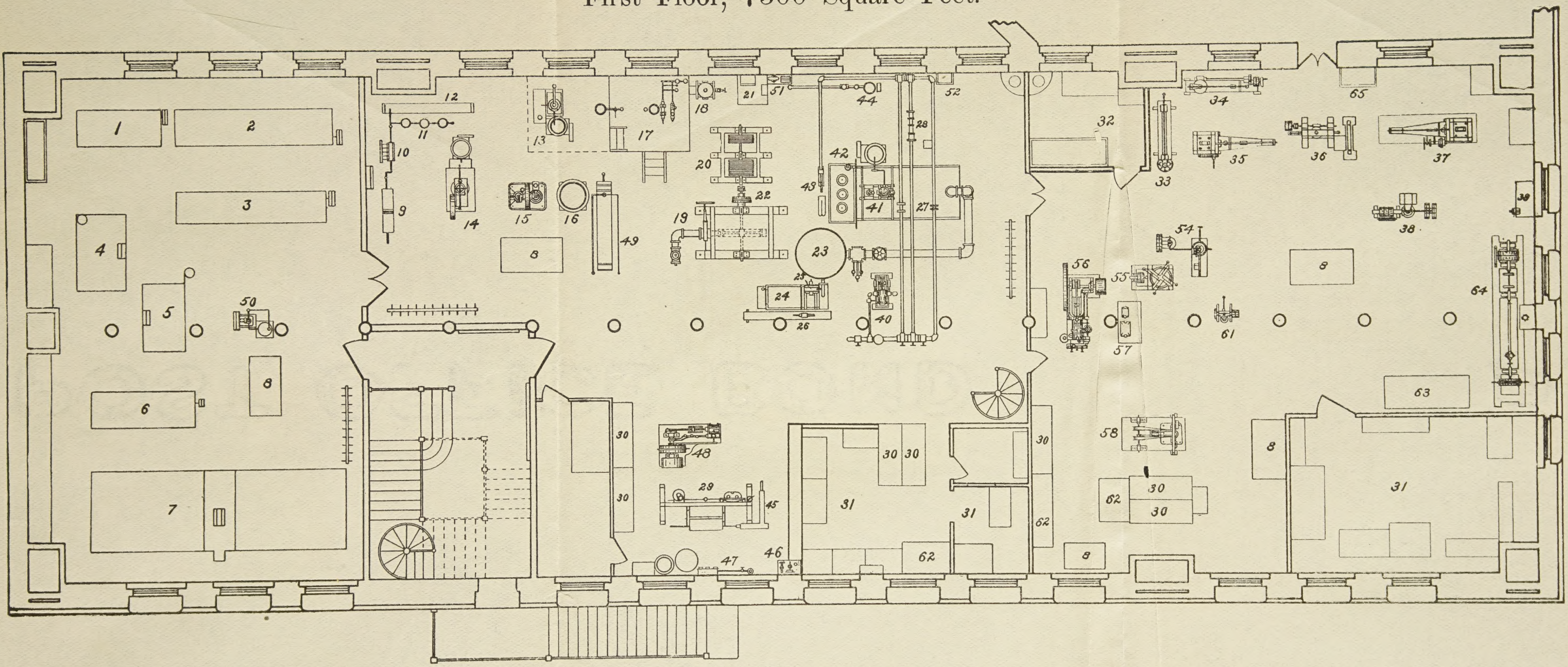
A plan of the Engineering Laboratories is appended as they are equipped at the beginning of the school year 1898–1899.

Boston, September, 1898.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

ENGINEERING LABORATORIES.

First Floor, 7500 Square Feet.



1. Drawing frame.
2. Speeder.
3. Fly frame.
4. Carding engine.
5. Carding engine.
6. Spinning frame.
7. Mule.
8. Tables.
9. Flow of steam apparatus.
10. Superheating calorimeters.
11. Throttling calorimeters.
12. Condenser.
13. Continuous water calorimeter.
14. Hot-air engine (Ericsson).
15. Hot air engine (Rider).
16. Supply tank for hydraulic ram.
17. Injector testing apparatus.
18. Apparatus for testing the force of the jet of an injector.
19. Pelton water-wheel.
20. Brake for Pelton water-wheel.
21. Mercury column.
22. Emerson power-scale.
23. Tank for hydraulic experiments.
24. Eight-inch weir.
25. Water motor.
26. Ejector.
27. Hydraulic apparatus.
28. Venturi meter.
29. Air-brake pumps.
30. Instrument cases.
31. Offices.
32. Room for mixing cement.
33. Machine for testing cement.
34. Machine for testing cement.
35. 50,000 pounds testing machine.
36. Cloth testing machine.
37. 100,000 pounds testing machine.
38. Wire testing machine.
39. Work bench.
40. Water motor.
41. Hydraulic ram.
42. Adjustable weir and tank.
43. Apparatus for testing hose nozzles.
44. Hydraulic stand-pipe.
45. Apparatus for testing anemometers.
46. Gauge tester.
47. Apparatus for determining the ratio of specific heats of gases.
48. Steam engine, 8 H. P.
49. Condenser.
50. Drosophore.
51. Water motor.
52. Seconds pendulum.
54. Gas Explosion apparatus.
55. Abrasion machine.
56. Gas engine, 4 H. P.
57. Gas meters.
58. Lubricant testing machine.
61. Webber dynamometer.
62. Cases.
63. Repeated stress testing machine.
64. Dynamometer.
65. Scales for sealing weights.

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